A CONTRIBUTION

TO THE

STUDY OF INTESTINAL SAND

WITH NOTES ON A CASE IN WHICH IT WAS PASSED

BY

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The occurrence of intestinal sand has attracted the attention of observers for some years past. Cases presenting this symptom appear to have been of singular infrequency in the British Isles, for it is scarcely possible that they can have been often overlooked. English literature on the subject is, however, almost a blank, and the best text-books in this country and in the United States of America make but little reference to it. A good many cases have been noted and reported on the continent of Europe. The object of this communication is to attempt

to place these examples of intestinal sand in their proper nosological position, and to record a case of true, as distinguished from false, enteric lithiasis which came under our observation in this country. The particulars of it are as follows:

A married lady, aged 33, residing in the provinces, and leading a healthy life, began to suffer from diarrhœa early in 1900, and came under the care of Dr. Surridge. No cause for this ailment was made out. The previous health had always been fairly good. The last confinement occurred three years ago. The house occupied by this lady is built on a sandy soil, and its drainage is reported to be in excellent condition and of recent arrangement. The water-supply is not good, being hard, and containing some organic impurities.

The family history was as follows:—Both parents are living. The father is a gouty man, and a brother and sister of his are gouty. There are five sisters and two brothers; one of the latter suffers from colic. Bowel disorders are said to be prevalent in the family. The youngest sister of the patient, twenty years her junior, suffered badly at one time from a wide-spread eczema. When this disorder was subdued she suffered from asthma, the two conditions alternating. After local treatment and internal medication with arsenic, she recovered her health. The patient has two daughters aged respectively seven and three years, both in good health.

After the last confinement this lady suffered occasionally from eczema around the anus for about eighteen months. When this condition yielded to local and general treatment she became subject to looseness of the bowels, having previously been of a constipated habit. Her weight in the summer of 1899 was nine stones and two pounds.

The present ailment began in January, 1900, with a very intractable diarrhœa, accompanied with internal rumbling and purring noises, there being six or eight loose motions in each twenty-four hours.

In the middle of February the patient took to her bed, and was ordered an exclusively milk diet with lime-water. This treatment lessened the diarrhœa to three or four motions each day, sometimes attended with the passage of mucus. On the 8th of March she was seen in consultation with Dr. Harris, of Manchester. Ten days later sand was discovered in the motions, and found subsequently in all in which it was looked for.

On the 23rd March, in Dr. Harris's absence, Dr. Dreschfeld's opinion was taken on the case. No ordinary methods of treatment had any effect in checking the diarrhœa and the formation of intestinal sand. The patient was sent up to London in April, and, in my absence from town, came under the care of Dr. Garrod. At this time two or three motions were passed each day. They were loose, brown in colour, and on tilting the bed-pan the gritty sand could be seen at the bottom of the vessel, each motion containing about a teaspoonful of it. Early in May I saw the patient with Dr. Garrod. She was pallid and sparely nourished. The thoracic organs were healthy. On examining the abdomen it was found that the colon and its sigmoid flexure were, though empty, too readily palpable, and apparently thickened in their walls. The right kidney was movable. There was a slight degree of pyrexia at this period, the temperature rising occasionally to 100° or a little above this. Specimens of the sand were obtained and submitted to examination. Full details of this are furnished in Dr. Garrod's report herewith. It will suffice to say here that it much resembled at first sight a deposit of uric acid, being of reddish-brown colour and finely gritty. It was insoluble in cold and boiling liquor potassæ, and readily soluble in boiling nitric acid. Under a low power of the microscope particles of various shapes and sizes were seen, of a brilliant reddish-brown hue, and translucent.

The patient was confined to bed and kept on milk diet. For medicine, salicylate of bismuth and bicarbonate of sodium were given in mixture. Under this treatment the

diarrhœa was somewhat checked and the general health improved. The motions were rather more consistent, stained by the bismuth, but still contained sand. Towards the end of May the patient sat up for some time daily and went out for short walks, but there was now complaint for the first time of pain in the large bowel. Chicken broth, turtle soup, mutton broth, and koumiss were now given, and a mixture containing carbonate of bismuth, opium, and tincture of cinnamon. There was gradual improvement in most respects, less pain, but a good deal of rumbling noise in the bowels. The patient returned home early in June and continued the treatment under Dr. Surridge's care. Some benefit was gained by taking Bael jelly, and also from a mixture containing some aromatic sulphuric acid, tincture of cinnamon, and opium. In July, by our advice, she went to Plombières under the care of Dr. Bottentuit. She took baths and had rectal douches, and drank the water in small quantities. All vegetable food was withheld, and digestion was found to be much more comfortable without it, as it caused immediate distension. She lost ten pounds in weight while at Plombières. The next month was spent in Folkestone with some benefit, and some weight was regained.

On her return home she reported herself very much better. Her general health and her nervous tone had improved. There was still diarrhœa, with much flatulence at intervals, and some, though less, sand, accompanied with a great deal of mucus. Dr. Bottentuit prescribed bicarbonate of sodium in teaspoonful doses with advantage for the flatulent attacks. The appetite was better, and more variety of food could be borne. During October there were alternations of constipation and diarrhœa, and a considerable quantity of sand was passed on October 12th. She was next seen in November. She was rather pallid and languid, was easily tired on exertion, but had regained her usual weight, nine stones and two pounds. The large bowel no longer appeared thickened, as it did

six months previously, but there was tenderness on pressure about the splenic flexure of it. There was still a looseness of the bowel, two to four actions occurring daily, but no sand was passed. Her diet was altogether of animal food, and a little whisky was taken with one meal. The urine was turbid with lithates and deposited uric acid. The tongue was large, flabby, and thinly grooved. A mixture with liquid extracts of cinchona and bael and tincture of cinnamon was ordered, and milk with natural seltzer water was added to her diet. The catamenia were regular. She returned home about the middle of the month.

This case presented most of the characters that have been described in the few instances of the disorder that are already on record. It was, however, remarkable for the little pain which was experienced. In most examples of enteric lithiasis this appears to be a marked feature, occurring in paroxysms, lasting several hours, somewhat akin to those associated with biliary and renal colic, and attended with much flatulent distension and vomiting. According to M. Dieulafoy, who has recorded a series of these cases, there is commonly a family history of gout, and he regards the condition as one of the irregular manifestations of this disorder in many, but not in all, instances. In this case there was a distinct gouty history on the father's side. In a large proportion of the recorded cases there has been noted the co-existence of muco-colitis, often attended with the passage of mucous casts and shreds. Diarrhœa occurs in some cases, and constipation in others. The subjects of the disorder in two thirds of the cases have been women, and the average age is about thirty-five years. Examples of it have been recorded in children under four years of age. Some of the cases described by Continental observers, as will appear from Dr. Garrod's inquiries, are not truly cases of enteric lithiasis, such as that here described, the so-called sand having been proved to consist of vegetable *débris* and not of inorganic matter.

Characters and Composition of the Intestinal Sand.

When washed and dried in the air, the gritty material passed with the motions had the appearance of a fine sand. Its ground colour was a deep brown, with an admixture of pale or almost colourless particles.

Under a low power of the microscope the individual granules were seen to have a great variety of shapes; some were roughly oval, some oblong or even rod-like, and others, again, were of very irregular outline. Their colour varied from yellow to a warm brown. Some were translucent and others opaque, with the exception of their edges. Some had a finely granular appearance, but none of them showed any indication of crystalline structure (Fig. 1).

Their longest measurements varied between 0·05 and 0·2 mm.

When treated with an acid beneath a cover-glass the particles became surrounded by groups of bubbles, and the solution of the inorganic constituents left exposed an organic basis, brown in colour, wholly structureless, and soluble in alkalies.

No cellular elements could be seen, and the organic basis certainly did not consist of vegetable *débris* of any kind. As in Eichhorst's case, the organic material, when washed with distilled water and stained with methylene blue, was seen to be rich in bacteria, both bacilli and micrococci being present in large numbers.

When, on the other hand, the organic material was got rid of by combustion, the particles of inorganic substance left appeared like decolourised shadows of the original granules, which they resembled both in shape and size.

The air-dried sand lost considerably in weight at 100° C., owing to the expulsion of water from the organic basis, and the percentages of water, organic and inorganic materials contained in it was found to be as follows:

Water	12·40
Organic material . . .	26·29
Inorganic material . . .	61·31
	100·00

The inorganic residue left after combustion over a Bunsen's burner had a bluish-white tint, and contained only a few dark particles. With the exception of such particles, it was completely soluble in hydrochloric acid. This residue was submitted to analysis, and was found to have the following composition:

Calcium oxide (CaO) . . .	54·98
Phosphorus pentoxide (P_2O_5) . .	42·35
Carbon dioxide (CO_2) . . .	2·20
Residue, containing traces of magnesium and iron	0·47
	100·00

The presence of magnesium was beyond doubt, but the quantity was extremely small. Calcium phosphate was clearly the chief mineral constituent.

The pigmentation of the sand proved to be somewhat complex, and the small remainder of the material available did not permit of a complete and satisfactory investigation from this point of view.

When some of the material was treated with acetic acid a scanty evolution of carbon dioxide was observed, and the gas rose to the surface in a stream of minute bubbles. The solution had the colour of brown sherry, and when filtered from the organic *débris* and shaken with ether, it imparted to the ether a delicate pink tint, whereas the subjacent liquid remained of a rich yellow colour. The extraction was repeated several times, and the collected ethereal extracts were next shaken with a small quantity of distilled water, whereupon the pigment left the ether and imparted to the water a rich pink

tint, which recalled that of a solution of acid hæmatoporphyrin.

When examined with the spectroscope this solution showed a broad absorption-band in the neighbourhood of the D line, which lay between

λ6120 and λ5370.

With hydrochloric acid solutions of the pigment the band appeared composite, consisting of two darker bands united by a dark shading, and the position of the component parts was approximately as follows:

First dark band . . .	λ6120—λ5890
Dark shading.	
Second dark band . .	λ5760—λ5460

A second band in the neighbourhood of the F line (λ5060—λ4860) corresponded in position with that shown by a dilute acid solution of urobilin, and was apparently due to a scanty admixture of that pigment.

When kept for a day or two, even in the dark, the pink solution became almost decolourised and the urobilin band alone remained visible. The pink pigment was also promptly decolourised by alkalies.

The very unstable pink colouring matter here present did not agree in its properties with any pigment, fæcal or other, with which we are acquainted.

The yellow liquid from which the pink pigment had been extracted with ether, showed the band of acid urobilin with great intensity, and urobilin was apparently the chief colouring matter of the sand. It had all the ordinary properties of urobilin, as obtained from urine or fæces; was precipitated by saturation of a watery solution with ammonium sulphate; yielded a green fluorescence with zinc chloride and ammonia, and showed the characteristic E-band spectrum when partially precipitated from a concentrated alkaline solution by the cautious addition of an acid.

The organic residue upon the filter-paper acquired a green tint on exposure to air, and when treated with a

solution of sodium hydrate, yielded a pale greenish-yellow solution, which did not become more distinctly green on standing, but which gave Gmelin's reaction. Hence it was evident that among the colouring matters present was a small quantity of unaltered bile-pigment.

Berlioz mentions the presence of urobilin in one of Dieulafoy's specimens, and Eichhorst observed the presence of biliverdin in some granules of the sand which he examined; but the only recorded case in which a special investigation of the contained pigments has been carried out is that of Thomson and Ferguson, who found, in addition to some urobilin, a pigment soluble in dilute hydrochloric acid and in alkalies, but insoluble in water, alcohol, ether and chloroform, and which was obviously not one of the recognised colouring matters of the bile.

We are greatly indebted to Drs. Thomson and Ferguson for the opportunity of examining a small quantity of the sand in question, which in appearance chiefly differs from ours in the larger size of the component granules. From a solution in acetic acid there was not extracted, by shaking with ether, any of the unstable pink pigment above described; and judging by the intensity of the absorption-band the amount of urobilin present appeared to be considerably less than in our specimens.

Varieties of Intestinal Sand.

Although the literature of intestinal sand is so scanty, two distinct classes of materials have clearly been described by this name. These require to be clearly distinguished from each other, and they may be conveniently described as *true* and *false* sand respectively.

1. *False* intestinal sand is composed of remains of vegetable foods which have resisted the action of the digestive fluids, and which may or may not have acquired some incrustation of earthy salts. One particular kind of vegetable *débris* is especially apt to appear as a sand-

like material in the motions, namely, the sclerenchymatous particles which are so abundantly present in the flesh of pears, and especially in that of certain varieties. The occurrence of such sand in the motions was described by C. Robin in 1873, and some at least of the specimens described by Laboulbène in the same year were obviously of this nature. Eichhorst described a case in 1889, and Fürbringer called special attention to this material as simulating biliary concretions. Naunyn also refers to it as one of the varieties of so-called *biliary sand.**

In this country specimens of this kind have been brought before the notice of the Pathological Society of London by Delépine and Shattock.

A specimen of *pear* sand in our possession, for which we are indebted to the kindness of Dr. J. H. Drysdale, is paler in colour and more coarsely granular (0·3—0·6 mm.) than that passed by our patient, and when burnt leaves only 1·76 per cent. of inorganic residue. Other observers have obtained from 2 to 3 per cent. of such residue, figures which contrast sharply with the much higher percentage of mineral constituents in specimens of *true* intestinal sand.

The microscopic appearance of the *pear* sand is very characteristic (Fig. 2). When examined under a low power the granules appear as if studded with projecting crystals, and after removal of any inorganic incrustation by an acid, they are seen to be composed of woody cells, the thick, transparent walls of which are traversed by channels running from the narrow cell-cavities towards the surface. In a word, the granules are easily recognised as identical with the particles of sclerenchymatous tissue in the fruit from which they are derived, and of which the patient will be found to have partaken freely. There is reason to believe that these woody particles may

* Since this paper was read we have found a description of the *pear* sand by Dr. Alexander Marcet, in his "Essay on Calculous Disorders," (p. 132) published in 1817. The description was based upon specimens the true nature of which had been recognised by Wollaston.

remain for some time in the intestine, and the expulsion of large accumulations of them may be preceded by severe colicky pain.

The presence of a black sand-like material in the motions, consisting of cells derived from the banana, has also been described by some American authors. The dark colour is apparently acquired during the passage of the cells along the alimentary canal.

2. *True* intestinal sand, on the other hand, of which the material passed by our patient offers an example, has no such vegetable basis, and, wanting such a rigid skeleton, it owes its hardness and grittiness to the much larger proportion of inorganic material which it contains. The organic basis of such sand is clearly of animal origin. Some of the published analyses of such materials show a very close resemblance to that of our specimen.

Thus Mathieu and Richaud analysed the sand passed by their two patients with the following results :

	Case I.	Case II.
Organic material .	30·800	45·80
Tricalcic phosphate	64·206	46·68
Calcic carbonate .	3·418	5·14
Various mineral substances	1·576	2·38
	100·000	100·00

Thomson and Ferguson's specimen had the following composition :

Organic matter .	28·5
Inorganic matter .	71·5
	100·0

In the inorganic residue :

Calcic carbonate .	11·7
Tricalcic phosphate	87·3
Insoluble residue (silica)	1·0
	100·0

Berlioz analysed one of Dieulafoy's specimens and obtained the following figures :

Water	11·25
Nitrogenous organic material of fæcal origin . . .	22·24
Fatty substances . .	Traces
Phosphoric acid . . .	17·56
Lime	26·22
Magnesia . . .	14·05
Silica	8·68
	100·00

In some other cases the proportion of inorganic material has been considerably less. Thus Marquez found—

Organic matter, of animal origin .	72
Inorganic, consisting of calcium phosphate and traces of carbonate	28
	100

In a case recorded by Biaggi, the sand was agglutinated into balls, 6—8 cm. in diameter, which readily disintegrated into sand. Much calcium phosphate was present, with traces of magnesium and sodium.

The material passed in Mongour's case was *gravel* rather than *sand,* and it occupies an intermediate place between intestinal sand and the large intestinal calculi which are sometimes met with, and which are usually composed, in large part, of ammonium magnesium phosphate. Most of the particles were of about the size of an orange pip, but some attained to the dimensions of nuts.

The analysis was as follows :

Organic material (by difference), water, iron . . .	29·28
Magnesium phosphate . .	26·82
Calcium carbonate . .	43·90
	100·00

Seat of Formation of "True" Intestinal Sand.

The question remains to be considered how and where sand of this description is formed. Its composition excludes a biliary origin, for it contains no cholesterin, and bile-pigment is only present in traces.

On the other hand, there is much that points to its origin in the intestinal tract. Such sand is practically always met with in association with intestinal disorders, and usually with muco-membranous colitis. The characters of the organic basis, and the large numbers of bacteria which are included in it, point to the intestine as the most likely seat of origin.

When our patient was taking bismuth salicylate the sand passed had a uniform grey tint, but this may have been due to the deposition of a mere surface coating of bismuth sulphide.

The richness of the material in urobilin and its poverty in unaltered bile-pigment affords a more satisfactory indication, and suggests that it is formed in a region in which the conversion of the bile-pigment into urobilin is already far advanced. There is good reason to believe that the principal seat of this change is in the upper regions of the colon.

Concretions, chiefly composed of calcium phosphate and carbonate, can hardly be formed in any but alkaline surroundings; but there is so much doubt as to the reaction of the contents of different parts of the intestinal tract, and especially under morbid conditions, that this does not afford any very clear indication of the exact locality in which the sand is formed.

The nature of the inorganic constituents is fully compatible with an intestinal origin. Nor is it necessary to look to unabsorbed residues of the calcium of the food as the sole source of supply, for Voit, Friedrich Müller, and von Limberg have shown that a large part of the calcium excretion of the body is effected by the intestine, an

Kobert and Koch found calcium, magnesium, and phosphoric acid in the material which accumulated in the empty and cleansed colon of a patient with a fæcal fistula.

Like Thomson and Ferguson's patient, ours had taken milk and lime-water freely, and, as Bunge has shown, the amount of lime contained in milk is actually greater than that present in an equal volume of lime-water; so that the former may be regarded as a more important source of calcium supply than the latter.

The above considerations leave little room for doubt that true intestinal sand has its origin in the intestinal canal, for chemical and clinical evidence alike point in this direction. The nature of the contained pigments suggests the colon as the most likely seat of formation, and the anatomical structure of the large bowel may be looked upon as more favourable than that of the small intestine to the sojourn required for the deposition of the earthy salts of which the material is so largely composed.

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FIG. 1.

True intestinal sand, from the case described.

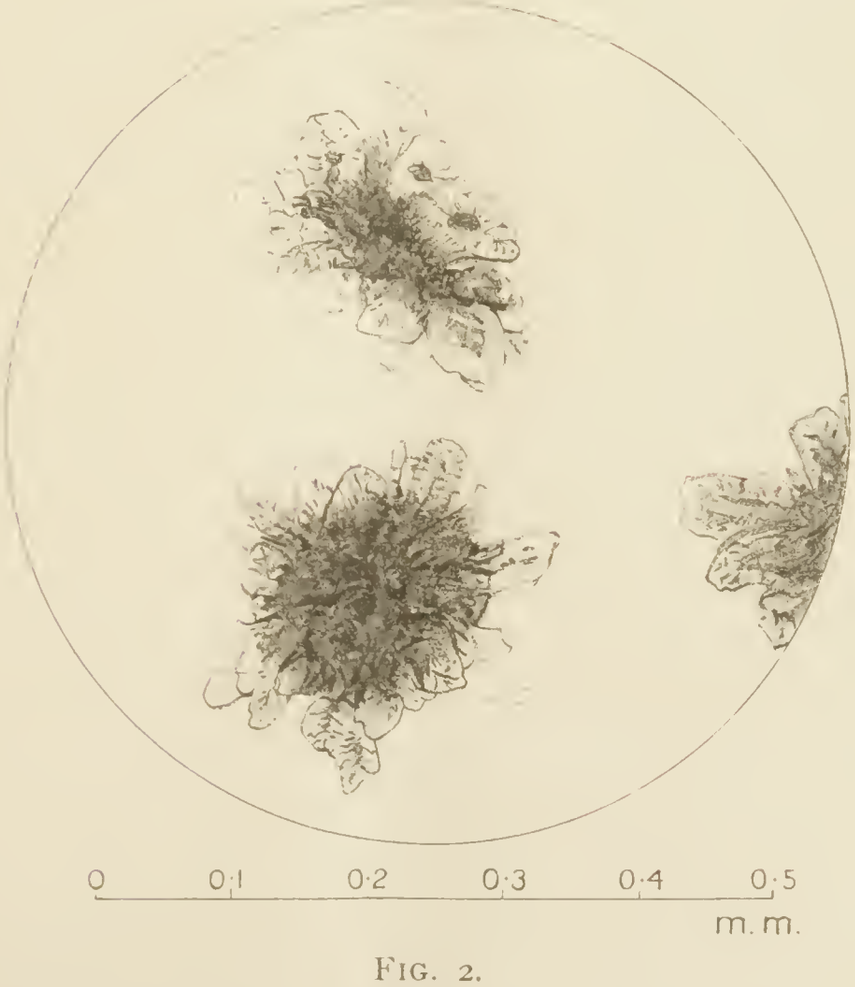

FIG. 2.

False intestinal sand, consisting of sclerenchymatous particles of pears.

Bale & Danielsson, Ltd., Lith